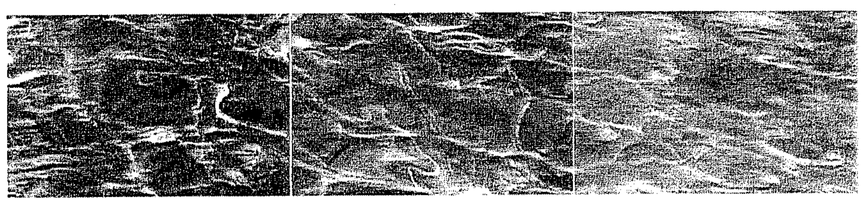

CITY OF SAN DIEGO WATER REUSE STUDY

Final Draft Report March 2006

ABBREVIATED VERSION by City Attorney Michael Aguirre
9-17-07

1.0 Introduction

This report presents the findings of the City of San Diego (City) Water Reuse Study (Study). The purpose of the Study is to evaluate opportunities available to the City to increase the city-wide beneficial use of recycled water. Together with the results of a broad public outreach and involvement process, the City will use the findings of this report to determine a future course for the implementation of water reuse projects.

1.1 Study Background

Currently, the 1.3 million people living in San Diego use an average of 210 million gallons per day (MGD) of potable water. The City's population is projected to increase 50 percent in the next 25 years. Even with additional water conservation measures, the City projects this population growth will increase demand for potable water by approximately 25 percent, or an additional 50 MGD.

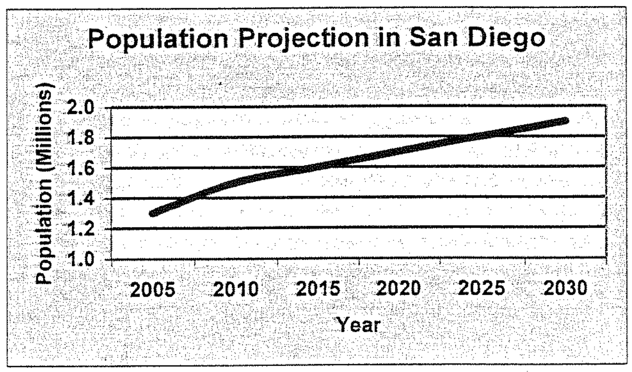

Figure 1-1
San Diego's population is anticipated to increase 50 percent by 2030.

Up to 90 percent of the City's existing water supply is imported from the Colorado River and the California State Water Project. The City has long recognized the need to develop local water supplies to balance and reduce this dependence on imported water.

Many factors outside the City also contribute to our future water needs and the reliability of existing supplies. California's access to surplus water from the Colorado River has been reduced, and recurring droughts in both the western United States and the Colorado River watershed have affected imported water supplies. Competing interests statewide between urban users, agricultural uses and environmental interests are being resolved, but water allocations to each will continue to be adjusted in the future.

In 1997, the City prepared the *Strategic Plan for Water Supply*, and in 2002 updated it with a more detailed *Long-Range Water Resources Plan* (Long-Range Plan). Both documents identified the need for the City to develop additional local water supply sources as a means of providing reliability and protection from water supply shortages. These recommendations were consistent with the sentiment expressed by the San Diego County Grand Jury in a 1999 report on San Diego's water supply. Having noted San Diego's dependence on imported water, the grand jury recommended the development of additional local supplies, including water reuse, quoted as follows:

Miscellaneous Uses

Although recycled water is used elsewhere in California for fire protection, snowmaking, construction/dust control, street sweeping, car washes and commercial laundries, these uses are generally small. With the exception of snowmaking, San Diego could use recycled water for these activities if these agencies and commercial enterprises expressed interest and the activities were in the vicinity of recycled water facilities, though it would need to be at the discretion of the City and the specific potential customers. Overall, these uses would tend to be relatively small compared to the potential of the other opportunities presented.

4.3 Indirect Potable Reuse Description and Project Types

The City purchases all of its imported water from the Water Authority, which in turn purchases its water from the Metropolitan Water District (MWD) of Southern California and the Imperial Irrigation District (IID). The water sold by MWD is a blend of Colorado River and California State Project Water, and the blend varies depending on price and supply availability. Approximately 80 to 90 percent of all drinking water in the City originates from these two sources.

California's annual use of Colorado River water has varied from 4.5 to 5.2 million AF over the last ten years. Historic and current use of up to 5.2 million AFY stems from the occurrence of surplus conditions and the availability of water apportioned to, but unused by, Arizona and Nevada. However, both states are approaching full use of their allocations, thereby reducing the likelihood that surplus Colorado River water will be available for purchase by MWD and other California water users.

In order to offset some of these losses to our future water supply, the Water Authority has reached an agreement to purchase up to 200,000 AF of Colorado River water apportioned to the IID. Part of this future supply will come from lining a 23-mile long section of the All American Canal, which currently loses approximately 67,700 AFY of water due to seepage into the ground.

The California State Project aqueduct is 444 miles long, starting from the Sacramento-San Joaquin Delta (Delta) and ending at Lake Perris in Riverside County. The Delta is a region where two of the California's largest rivers meet. Freshwater from the rivers mixes with saltwater from the Pacific Ocean, creating the West Coast's largest estuary. About two-thirds of all Californians and millions of acres of irrigated farmland rely on the Delta for water to supply the State Water Project and the federal Central Valley Project.

Unlike most river-supplied cities, San Diego's source water supply (a blend of local runoff, State Water Project and Colorado River waters), is of fairly good quality. That is not to say it is pristine mountain spring water. A few notable water agencies, including the City of San Francisco which receives 94% of its water from the Hetch Hetchy Reservoir filled with snowmelt from mountains in Yosemite National Park, and New York City, which receives over 90% of its water from highly protected watersheds in the Catskill Mountains, are exempt from federal treatment and filtration requirements prior to delivery to their customer's taps.

Conversely, San Diego's source water is superior to cities receiving water from the Mississippi River, Missouri River, or other rivers flowing through the central portion of the United States that have severely impacted water quality.

The Colorado and Sacramento-San Joaquin Rivers, like most rivers that pass through or near major cities, receive treated municipal wastewater and industrial inflows from upstream cities which blends with the river supply of downstream cities. The City of Las Vegas, for instance, discharges roughly 180,000 AF of tertiary treated municipal wastewater into Lake Mead each year, or about 2% of the total lake volume (as of November 2005 according to the U.S. Bureau of Reclamation volume data for Lake Mead; this percentage varies with lake volume). In addition to Las Vegas, there are about 650 total permitted dischargers, of which 360 are municipal and industrial dischargers into the Colorado River, upstream of the Colorado River Aqueduct intake point. Of these dischargers, 130 are relatively large dischargers (greater than 1.5 AF per day) and account for about 96.8% of the 2,610 AF per day of the total discharge back into the Colorado River. According to a 2004 U.S. Geological Survey (USGS) report on flow in the Colorado River Basin, the average daily river flow between 2001 and 2003 was slightly less than 14,800 AF per day. This roughly equates to discharges from Municipal and Industrial users into the Colorado River equaling 17.6% of the total river flow.

In the Sacramento and San Joaquin Rivers there are 339 permitted dischargers returning about 6,480 AF per day into these rivers (as of June, 2005). There are 137 relatively large dischargers (greater than 1.5 AF per day) along the Sacramento and San Joaquin Rivers accounting for about 98.8% of the total permitted discharges, however, these include agricultural returns as well as permitted municipal wastewater and industrial inflows. According to the California Department of Water Resources, the uninterrupted runoff into the combined Sacramento and San Joaquin Rivers averages about 68,800 AF per day. Therefore, discharges roughly equate to about 9.4% of the total combined river flow.

San Diego fully treats the "raw" or untreated water it receives using a conventional treatment process of chemical coagulation, flocculation, sedimentation, filtration and disinfection. Using this "conventional" treatment process, which most cities in the United States also use, San Diego has always met the water quality standards set by the EPA and DHS Drinking Water Standards. The City successfully removes all regulated chemical compounds and potential bacterial or protozoan pathogens to below the levels mandated for public health reporting to these regulatory agencies. For over 105 years, the City of San Diego Water Department has successfully delivered safe drinking water to all of its customers and continues to surpass all water quality standards set by state and federal public health agencies.

In side-by-side water quality analyses, tertiary treated water produced at the NCWRP has shown to have comparable or lower levels of all regulated chemical compounds compared to raw water supplies at lakes Miramar and Murray. Should the City proceed with an IPR project, such as augmenting a reservoir or groundwater basin with advanced treated water (post tertiary treatment, membrane filtration, reverse osmosis and advanced oxidation/disinfection), the same would hold true. In short: the resulting recycled water would be of superior quality to our current raw water supply.

Whenever a wastewater treatment plant discharges to surface water or groundwater that serves as a drinking water source for downstream cities, a form of IPR occurs, often referred to as safe drinking water.

States are also free to set their own standards, but state standards must be "at least as stringent as the federal standard". California drinking water standards are set by the DHS using risk assessment information developed by the California Office of Environmental Health Hazard Assessment (OEHHA). California typically sets more stringent drinking water standards than those established by the EPA. The DHS sets drinking water maximum contaminant levels (MCLs) that carefully balance the health benefits with permit compliance feasibility/cost using the best available information. Water recycling projects that involve human contact (including drinking water) must meet these standards. Typically, the DHS includes drinking water MCL compliance requirements in the operating permits for recycled water projects that involve potential human contact. DHS can take enforcement action where compliance is not achieved.

In addition to establishing drinking water MCLs, DHS has developed enforceable regulations and guidance for recycled water projects. These are part of the permit issuance process the California regulatory agencies require cities and water districts to follow prior to granting approval for a recycling project to operate. The RWQCB issues the permits. DHS consults with the RWQCB and approves the public health and treatment requirements. To ensure that the proposed treatment method, distribution, and monitoring produces recycled water that meets the permit requirements and protects public health, the DHS evaluates every proposed water reuse project on a case-by-case basis.

Multiple-Barrier Approach to Public Health Protection

A multi-barrier water treatment approach is a proven means of protecting public health. Numerous, but not all, contaminants are regulated in drinking water and recycled water. The reason some contaminants are not regulated is because monitoring methods either do not exist or are too complicated for routine monitoring, or there is no reason to believe the contaminants are present to begin with. DHS regulators manage this uncertainty by using what is referred to as a multiple-barrier treatment approach (Velz, 1970; AWWA, 1987). This means that several treatment processes are used in a sequence to remove contaminants. In this manner, if one treatment barrier were to fail, the later independent treatment barriers would still insure proper treatment and removal of contaminants.

The multi-barrier approach is used for both drinking water treatment and recycled water treatment (Davies et al, 2003; Luna et al, 2004). It includes source control (prevention of contaminants from entering the water supply), use of multiple water treatment processes, and water quality monitoring and surveillance. The basis of this approach is to ensure that there are prudent checks and balances in place to minimize the risk of failure and, ultimately, prevent exposure of consumers to unsafe water. A major advantage of the use of multiple-barrier water treatment methods is that the methods can also be effective at removing unknown contaminants.

Source Control

An increasingly important additional barrier against unknowns is the use of source control. Source control requirements are part of the permit process to utilize recycled water as they identify and minimize the introduction of contaminants into the wastewater, eliminating the need for them to be removed through treatment. The City's Metropolitan Wastewater Department (MWWD) regulates the quality of the wastewater that enters the wastewater system through an enforceable Industrial Wastewater Control Program (City of San Diego, 2005; EPA, 1992). A joint effort between the City, other agencies served by the system, and local industry, the program issues discharge permits, performs inspections, conducts wastewater monitoring, and enforces discharge standards at businesses and industries throughout the service area.

Similarly, the Orange County Sanitation District (OCSD) is adopting an enhanced source water control program that expands the list of pollutants of concern entering the treatment plant to include regulated and newly discovered drinking water contaminants. The OCSD will provide treated wastewater as the source water for the Orange County Water District's (OCWD) advanced treatment Groundwater Replenishment Project.

4.5 Water Treatment Technology

With today's technology, there are many differing individual treatment methods that can be linked together to provide water treatment for recycled water uses. In a multi-barrier approach these methods are carefully selected and placed in a specific order in a treatment plant depending on the required water quality needed. Both public health and the quality of water needed for the specific use guide the level of treatment needed. A more detailed description of water treatment methods and additional references is included in Appendix G.

Water treatment methods can be used to remove or reduce broad classes of contaminants including:

- Microorganisms (disease-causing bacteria, viruses and protozoa),
- Organic chemicals (pesticides, herbicides, trace contaminants),
- Inorganic chemicals (metals, nutrients, and minerals),
- Physical measurements (color, turbidity, and odor), and
- Radiologicals (radioactive substances).

Recycled water treatment methods are specifically designed and sequenced to reduce the amount of these contaminants to levels that consider the end use and protect the health of the public. Importantly, the treatment methods also provide multiple barriers to remove other similar contaminants. The effectiveness of removal depends on the method selected and how it is designed, operated and maintained. The general ability of each of the treatment methods to address classes of contaminants in water is shown in **Table 4-1**.

Non-potable reuse applications generally use source control, primary treatment, secondary treatment, tertiary treatment and chlorine disinfection. Special uses like industrial boiler water supply may require additional treatment to remove inorganic minerals that might damage the boiler.

Because the water will ultimately be consumed by people, IPR projects incorporate advanced water treatment methods (often including additional pretreatment). DHS requires RO and ultraviolet disinfection (UV) plus hydrogen peroxide in IPR projects to address health concerns related to trace organic contaminants, such as pharmaceuticals and personal care products (PPCPs). The City has many years of experience testing RO systems. In fact, results from regulated, intentional and non-intentional releases of radioactive substances from industrial sources (such as hospitals and pharmaceutical companies) into wastewater systems can occur. IPR projects must measure and meet drinking water standards for radioactive substances.

Use of Multiple Barrier Treatment for Indirect Potable Reuse

Drinking water treatment as regulated by the DHS uses a "multiple- barrier approach" (Velz, 1970, AWWA, 1987). Each of the treatment barriers is designed by engineers to be as independent as possible such that, if one temporarily fails, the others ensure the safety of the water. Also, because each treatment barrier is not equally effective for every contaminant, barriers are selected, designed and built to produce the desired end water quality in the aggregate. In general, the lower the chances of human contact with the water, the less elaborate the water treatment. Since IPR involves human consumption of the water, California law requires very high levels of treatment and monitoring.

The multi-barrier treatment approach also provides significant protection against unknown or unmeasured contaminants. Technologies remove a range of substances, not just those that are identified. For example, a group of contaminants called nitrosamines received significant attention as potent carcinogens produced by the conversion of nitrite (from cured meats and other sources) in the stomach (NAS, 1992), and also found in some foods.. There are several nitrosamines that are chemically similar, differing only by the length and composition of the organic side-chain attached to the nitrosamine group. One of them, NDMA, has a California standard (notification level) associated with it. N-nitroso*diethyl*amine, or NDEA, is believed to potentially co-occur with NDMA but there are no occurrence data available Further, NDEA may present a similar health risk (IRIS, 2004). The water treatment technology (UV + hydrogen peroxide) that is effective for NDMA destruction in wastewater (Soroushian et al, 2001) is also likely to be effective for NDEA because it is structurally similar to NDMA. Thus, while there is no standard or routine monitoring for NDEA, the treatment method used to control NDMA also controls NDEA (and many other unknowns).

Another example is harmful bacteria and viruses. Physical removal processes (like filtration or RO) are broadly effective against these organisms, not just the ones we can detect. Similarly, disinfection (by chlorine, ozone, UV, etc.) works against all these organisms. Disinfection effectiveness can vary by the type of organism but the "treatment barrier" provides broader protection against health risks beyond the ones we know about.

No single treatment method is an absolute barrier to pathogens or chemical contaminants. A series of treatment methods that includes RO treatment is the most aggressive and thorough approach. Combinations of the treatment methods detailed above can be configured to meet all current and draft water quality regulations in existence both in California and elsewhere.

To comply with the DHS requirements for IPR, and to protect public health and safety, a City reservoir augmentation project would begin with treated high quality recycled water from the NCWRP or the SBWRP and would be configured to provide additional advanced treatment as indicated in **Figure 3-1** below.

As shown in the figure, the required IPR treatment train could follow two paths: reservoir augmentation or groundwater recharge. Either train would use RO followed by advanced oxidation. The advanced oxidation process would provide high levels of additional disinfection and destruction of organic chemicals. Ion exchange (IX) is included only as an optional treatment based on the results of recent full scale plant studies at OCWD and West Basin Municipal Water District that show modern membranes are so effective at nitrate rejection that IX is not required. GAC is an optional process that could provide yet another organics removal barrier. It is not typically included in IPR projects but could be if the community deems additional barriers are desirable and affordable. Wetlands treatment could be added but, given the high quality of the water entering the wetland, it is likely that the water quality would be degraded in a wetland due to plant decay products, wildlife fecal contamination and salt increase due to evaporation of water through plants.

The treatment process train as depicted in **Figure 3** is capable of producing an exceptionally high quality of water in comparison to virtually any existing drinking water treatment plant in the United States.

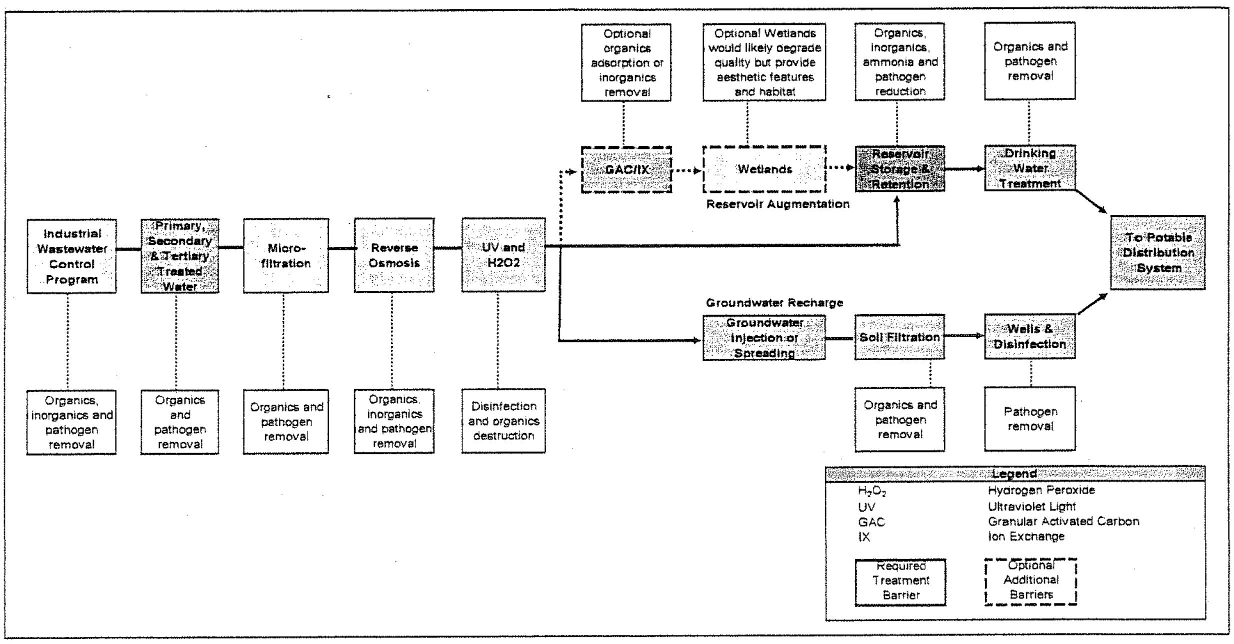

Figure 3 – Multi-barrier Treatment Methods for Indirect Potable Reuse

The water treatment methods are selected to produce a water quality that more than meets the regulatory requirements for the expected end use of the water (in the example above, IPR).

The use of multiple treatment barriers is the basis of all recycled water regulation. A major advantage of the use of multiple barrier water treatment methods is that the methods can also be effective at removing unknown contaminants that are similar in chemical structure or behavior to the ones we actually know about.

The general potential of different treatment methods to remove classes of contaminants in water is shown in **Table 3**. The effectiveness of the method depends on the nature of the contaminant, the design of the method as well as how it is operated.

6.0 Indirect Potable Reuse Opportunities

Indirect potable reuse (IPR) is the practice of taking recycled water that meets all regulatory requirements for non-potable use, treating it further with several advanced treatment processes to meet potable water standards, and adding it to an untreated potable water supply, usually a water body such as a surface water reservoir or a groundwater aquifer. The term "indirect" refers to the distinction that highly-treated recycled water is not plumbed directly to the potable distribution system. During a long residence time, the highly-treated recycled water blends with the source water, which is usually imported water and local runoff. This process is illustrated in **Figure 6-1**.

Extensive permitting and regulatory interaction is required prior to starting an IPR project. Regulations require the recycled water receive extensive advanced treatment, plus additional natural treatment processes that occur in a groundwater basin, stream or lake. Prior to entering the City's potable water system, the blended source water is treated at a potable water treatment plant or at a wellhead treatment facility. Treatment methods for IPR projects are described in detail in Appendix G.

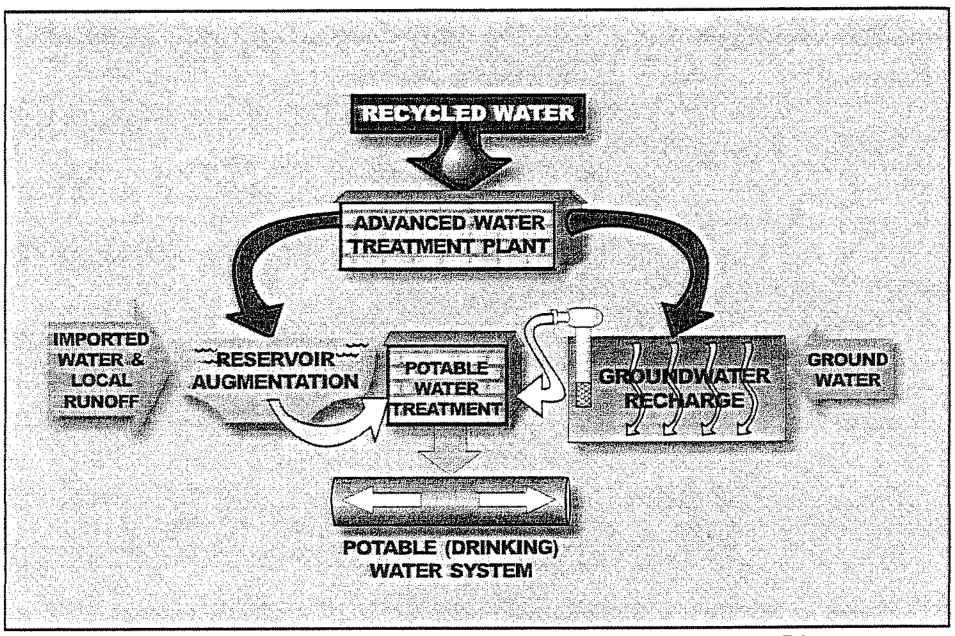

Figure 6-1 – Conceptual Indirect Potable Reuse Process Diagram

Section 2 Recycled Water Regulations and Uses

California has developed enforceable regulations in addition to issuing guidance and recommendations. These regulations and guidance documents are part of the permit issuance process the California regulatory agencies require cities and water districts to follow prior to gaining approval for a recycling project to operate. The regulation of recycled water is found in several State documents. These are briefly described below.

Porter-Cologne Act

While the history of California water use and protection regulations extends back to the early years of the 20th Century, the heart of today's current regulations is the landmark 1969 Porter-Cologne Water Quality Act. Sections of the Act were used as the basis for the 1972 Federal Water Pollution Control Act, commonly known as the CWA.

Under "Porter-Cologne", the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs) are given the authority to preserve and enhance beneficial uses of the State's waters. Beneficial uses include all the uses we make of water supplies including fishing, swimming, boating, irrigation, drinking water, etc. The Act is contained in the California Water Code, Division 7 – Water Quality, and has been modified and amended through the years to address new issues and concerns affecting water use, clean water, water conservation, reuse, and water quality. RWQCBs issue the recycled water permits under State law but rely on the advice and consent of DHS regarding public health.

Health and Safety Code

In California, Part 12 of the Health and Safety Code contains the California Safe Drinking Water Act, which addresses health aspects of drinking water. The Porter-Cologne Act refers to the Health and Safety Code and defers to its interpretation of what is harmful or hazardous to human health (hence the involvement of DHS). The water produced by indirect potable reuse projects must also comply with the California Safe Drinking Water Act requirements.

California Code of Regulations

The provisions of both the Porter-Cologne Act and the Health and Safety Code are included as enforceable regulations in the California Code of Regulations (CCR) under *Title 22 – Social Security*. Relevant topics under this heading include water recycling criteria and water permits.

State Guidance and Policy Statements

While the CCR contains established and enforceable regulations, the DHS has issued a number of guidance documents addressing water recycling. Several are listed below:

- *California Health Laws Related to Recycled Water* (State of California, June 2001)
- *Guidelines for the Preparation of an Engineering Report for the Production, Distribution, and Use of Recycled Water* (State of California, March 2001)
- *Treatment Technology Report for Recycled Water* (State of California, September 2004)

State Regulation of Water Recycling

While regulations mandate that water for consumption be of the highest quality and safe to drink, non-potable or non-consumptive uses also require high quality water that must be treated to standards appropriate for its intended use.

Regulation of Recycled Water for Non-Potable Uses – Section 13521 of the Porter-Cologne Act grants DHS the authority to set criteria for recycled water use where such use would require specific protection of public health. As a result, DHS developed comprehensive uniform regulations that establish acceptable uses of recycled water, water quality, and treatment process requirements to ensure that recycled water use does not pose health risks, use area requirements, engineering report requirements, reporting and record keeping requirements, and design requirements to ensure operational reliability of treatment. These requirements are regulated under Title 22 of the California Administrative Code (Title 22, California Code of Regulations, §60301 *et seq.*) and enforced by the RWQCBs and each issues permits for individual projects to conform to the regulations and recommendations adopted by DHS.

California has a number of definitions for differing grades of recycled water based on level of treatment and effluent water quality criteria. The basic water quality criteria for recycled water in most water recycling permits are the MCL of chemicals and microbes allowed in drinking water. These standards generally apply to both non-potable and indirect potable uses of recycled water.

Proposed Draft Groundwater Recharge Regulations for Indirect Potable Reuse – The indirect use of recycled water to augment potable supplies is permissible under California law and is currently allowed through groundwater recharge using direct injection or surface spreading and, potentially, through addition to surface water reservoirs (State of California, 2001, 2004). The DHS evaluates every proposed project on a case-by-case basis to assure that the proposed treatment method, distribution and monitoring produces recycled water that is protective of public health.

The DHS has issued draft groundwater recharge reuse regulations (December 2004). The draft regulations are applicable to all groundwater recharge reuse projects which the State defines as "one that uses recycled water and has been designed, constructed, or operated for the purpose of recharging by infiltration or injection of recycled water, a groundwater basin designated in the Water Quality Control Plan for use as a source of domestic water supply."

The draft regulations require the control of contaminants at the source, multi-barrier treatment methods to control pathogens, inorganic and organic contaminants, treatment standards, recharge methods, extraction well location, and monitoring requirements. DHS is currently accepting comments on the draft regulations. While this is only a draft rule, DHS is incorporating the rule in their issuance of mandatory permits that recycled water producers must obtain from the State prior to operation. In addition to groundwater recharge projects, key parts of these draft rules would be applied to reservoir augmentation projects as well (DHS, personal communication, January 2005).

Although regulations related to groundwater recharge projects are still in the proposal stage, guidelines and criteria in place reflect a conservative approach by the DHS toward short-term and long-term health concerns.

HEALTH AND SAFETY CODE

Division 104. Environmental Health Services
Part 12. Drinking Water
Chapter 4. California Safe Drinking Water Act

Article 7. Requirements and Compliance

116551. Augmentation of source with recycled water

The department shall not issue a permit to a public water system or amend a valid existing permit for the use of a reservoir as a source of supply that is directly augmented with recycled water, as defined in subdivision (n) of Section 13050 of the Water Code, unless the department does all of the following:

(a) Performs an engineering evaluation that evaluates the proposed treatment technology and finds that the proposed technology will ensure that the recycled water meets or exceeds all applicable primary and secondary drinking water standards and poses no significant threat to public health.

(b) Hold at least three duly noticed public hearings in the area where the recycled water is proposed to be used or supplied for human consumption to receive public testimony on that proposed use. The department shall make available to the public, not less than 10 days prior to the date of the first hearing held pursuant to this subdivision, the evaluations and findings made pursuant to subdivision (a).

Chapter 5. Water Equipment and Control

Article 2. Cross-Connection Control by Water Users

116800. Control of users

Local health officers may maintain programs for the control of cross-connections by water users, within the users' premises, where public exposure to drinking water contaminated by backflow may occur. The programs may include inspections within water users premises for the purpose of identifying cross-connection hazards and determining appropriate backflow protection. Water users shall comply with all orders, instructions, regulations, and notices from the local health officer with respect to the installation, testing, and maintenance of backflow prevention devices. The local health

13554. Recycled water for toilet and urinal flushing

(a) Any public agency, including a state agency, city, county, city and county, district, or any other political subdivision of the state, may require the use of recycled water for toilet and urinal flushing in structures, except a mental hospital or other facility operated by a public agency for the treatment of persons with mental disorders, if all of the following requirements are met:

> (1) Recycled water, for these uses, is available to the user and meets the requirements set forth in Section 13550, as determined by the state board after notice and a hearing.
>
> (2) The use of recycled water does not cause any loss or diminution of any existing water right.
>
> (3) The public agency has prepared an engineering report pursuant to Section 60323 of Title 22 of the California Code of Regulations that includes plumbing design, cross-connection control, and monitoring requirements for the use site, which are in compliance with criteria established pursuant to Section 13521.

(b) This section applies only to either of the following:

> (1) New structures for which the building permit is issued on or after March 15, 1992, or, if a building permit is not required, new structures for which construction begins on or after March 15, 1992.
>
> (2) Any construction pursuant to subdivision (a) for which the State Department of Health Services has, prior to January 1, 1992, approved the use of recycled water.

(c) Division 13 (commencing with Section 21000) of the Public Resources Code does not apply to any project which only involves the repiping, redesign, or use of recycled water by a structure necessary to comply with a requirement issued by a public agency under subdivision (a). This exemption does not apply to any project to develop recycled water, to construct conveyance facilities for recycled water, or any other project not specified in this subdivision.

13554.2. DHS fees

(a) Any person or entity proposing the use of recycled water shall reimburse the State Department of Health Services for reasonable costs that department actually incurs in performing duties pursuant to this chapter.

Table 1
Treatment Levels for Allowable Recycled Water Uses

Types of Recycled Water Use	Recycled Water Treatment Level		
	Disinfected Tertiary	Disinfected Secondary	Undisinfected Secondary
Urban Uses and Landscape Irrigation			
Fire Protection	✓		
Toilet and Urinal Flushing	✓		
Irrigation of Parks, Schoolyards, Residential Landscaping	✓		
Irrigation of Cemeteries, Highway Landscaping		✓	
Irrigation of Nurseries		✓	
Landscape Impoundment	✓	✓ *	
Agricultural Irrigation			
Pasture for Milk Producing Animals		✓	
Fodder and Fiber Crops			✓
Orchards (no contact between fruit and recycled water)			✓
Vineyards (no contact between fruit and recycled water)			✓
Non-Food Bearing Trees			✓
Food Crops Eaten After Processing		✓	
Food Crops Eaten Raw	✓		
Commercial/Industrial			
Cooling & Air Conditioning – w/ cooling towers	✓	✓ *	
Structural Fire Fighting	✓		
Commercial Car Washes	✓		
Commercial Laundries	✓		
Artificial Snow Making	✓		
Soil Compaction, Concrete Mixing		✓	
Environmental and Other Uses			
Recreational Ponds with Body Contact (Swimming)	✓		
Wildlife Habitat/Wetland		✓	
Aquaculture	✓	✓ *	
Groundwater Recharge			
Seawater Intrusion Barrier	✓ *		
Replenishment of Potable Aquifers	✓ *		

* Restrictions may apply

Source: WaterRecycling 2030, California's Recycled Water Task Force, June 2003.

waiver, found itself sued by the U.S. Environmental Protection Agency (EPA) and other environmental organizations, reapplied for and been approved for a waiver, and settled the lawsuit. These events are summarized below:

1963: The City begins treating wastewater at the new Point Loma Wastewater Treatment Plant.

1972: Congress passes the CWA, requiring wastewater treatment plants to provide secondary treatment, but allowing certain ocean dischargers to apply for waivers.

1987: Following the City's withdrawal of its waiver application, the EPA and environmental organizations sue the City for non-compliance with the CWA.

1994: Congress passes the Ocean Pollution Reduction Act (OPRA), allowing the City to reapply for a waiver. The City reapplies and a waiver is granted. The City settles the lawsuit, and begins work to achieve 45 MGD in water reclamation capacity by 2010, a condition of OPRA.

The City has fulfilled its treatment capacity commitment with the completion of the 30 MGD North City Water Reclamation Plant in 1997, and the 15 MGD South Bay Water Reclamation Plant in 2002.

1995: An EPA grant for construction of the City's NCWRP requires the City to attempt to meet a goal of reusing 25 percent of treated flows by 2003 and 50 percent of the plant's treated flow by 2010. Based on anticipated wastewater flows to the NCWRP, the City established reuse goals consistent with the above commitments of 6 MGD by the end of 2003, and 12 MGD by the end of 2010.

2002: The City fulfills the 45 MGD treatment capacity requirement with the completion of the 30 MGD NCWRP in 1997, and the 15 MGD SBWRP in 2002. After allowances for treatment process losses and other on-site uses, these two reclamation plants have recycled water production capacities of approximately 24 MGD and 13.5 MGD, respectively.

2004: The City enters into a Settlement Agreement with environmental organizations, committing to conduct a comprehensive study of opportunities to make beneficial use of the City's recycled water. The Settlement Agreement commits the City to: (a) evaluate improved ocean monitoring; (b) pilot test biological aerated filters as a form of technology to increase solids removal; and (c) study increased water reuse. This Study is intended to investigate methods to augment the City's use of recycled water.

The Water Reuse Study is intended to fulfill part (c) of the Settlement Agreement with environmental stakeholders to study increased water reuse.

Water Repurification Project

Beginning in 1993, the City, in cooperation with the Water Authority, proposed an IPR project called the Water Repurification Project. The project proceeded through various phases of planning, regulatory reviews, and preliminary design prior to being cancelled by Council in treatment and dilution.

The health risk of drinking water treated from the San Vicente Reservoir after augmentation with recycled water was concluded to be no greater than drinking water treated from non-augmented sources (Western Consortium for Public Health, 1996, Olivieri et al, 1996).

Recent discussions with California DHS regarding indirect potable reuse – Preliminary discussions with DHS representatives in January 2005 indicated that any new proposal for a reservoir augmentation project would need to consider the changes made to the Draft Ground Water Recharge regulations (State of California, December 2004) since approval of the City's 1998 Water Repurification Project. As described above, the new draft regulations have more strict requirements on total organic carbon, nitrogen, and source control. In addition, the RWQCB may add more requirements for inflows to the reservoir, particularly with regard to nitrogen. DHS would likely require two treatment barriers for each type of contaminant. As long as the project meets all DHS treatment and reservoir management requirements, introduction of highly treated recycled water into a drinking water treatment plant source reservoir could be permitted.

Section 5 Other Community Experiences

Montebello Forebay Groundwater Recharge Project, Los Angeles County

The oldest and most successful planned IPR project continues to expand because of its history of leadership in recycled water research and the project's advanced water quality monitoring program. This recycled water spreading project, begun in 1961, has contributed over the years numerous landmark recycled water treatment and health effects studies that have advanced other such projects, and increased our knowledge in the area of operations, maintenance, and water quality monitoring.

In the County of Los Angeles, the Montebello Forebay Groundwater Recharge Project is part of the San Gabriel River Conservation System. Today runoff, impounded water from canyon dams, recycled water from three County Sanitation Districts of Los Angeles County (CSDLC) treatment plants, and imported surface water can be directed to spreading grounds at points along the length of the river for the purpose of groundwater recharge in the San Gabriel Valley and the coastal plain.

The planned use of recycled water for groundwater recharge in the Montebello Forebay began in 1962. Today, three treatment plants designed, built, and operated by the CSDLC provide recycled water for spreading in the Rio Hondo and San Gabriel recharge basins. CSDLC's goal is to recycle as much water as possible.

Recycled water quality must comply with all drinking water standards established by DHS as determined by a running annual average.

Three major health effects studies and many water quality and operational research studies have been conducted on this reuse project over the years. The focal point of these studies was the Montebello Forebay. The first epidemiological study was initiated in 1979 and examined health outcomes from 1969 – 1980 (Frerichs, 1984). The study found no evidence of adverse health effects.

In 1987, a Science Advisory Panel on Groundwater Recharge with Reclaimed Water, created by the same state water agencies that created the 1975 expert panel, reviewed the OLAC Health Effects Study and endorsed the continuation of the Montebello Forebay recycled water spreading project. A second study of cancer incidence, mortality and incidence of infectious disease health outcomes from 1987 – 1991 (Sloss et al, 1996) and a third study examining birth outcomes from 1982 – 1993 (Sloss et al, 1999) were completed. The studies have shown no evidence of adverse effects.

Occoquan Reservoir Replenishment, Virginia

The Occoquan Reservoir is the principal water supply source for over one million people in Fairfax County, Northern Virginia. The 1,475-km2 (570 sq-mile) Occoquan Watershed was largely rural until the 1960's. Rapid growth led to water quality problems in the reservoir. The Upper Occoquan Sewage Authority (UOSA) water reclamation plant has added recycled water to the Occoquan Reservoir since 1978. The Occoquan Reservoir is a water source for the Fairfax County Water Authority's drinking water treatment plant. Recycled water from the UOSA water reclamation facility is discharged into Bull Run, a tributary of the Occoquan Reservoir, and then travels approximately six miles downstream to the reservoir. In periods of drought the plant supplies up to 90 percent of the reservoir's inflow. The water quality of the recycled water discharge is typically better than the water quality in the receiving stream and in the reservoir. After entering the reservoir, the water is then carried an additional 20 miles to the Fairfax County Water Authority's drinking water treatment plant inlet. The reclamation plant's discharge into the reservoir was at first a source of considerable controversy. Studies on the quality of the water are regularly conducted. These have established that the water from the plant is comparable to and may be better than the reservoir's other water sources.

One study investigated UOSA's treatment methods as barriers to pathogenic as well as alternative and traditional-indicator microorganisms. Samples were collected once a month for one year from eight sites within UOSA's advanced water reclamation plant. The eight sites were monitored for indicator bacteria total and bacteria, viruses and protozoa. Overall, the plant was able to achieve 99.999 percent to 99.99999 percent reduction of bacteria, 99.999 percent reduction of enteroviruses, and over 99.99 percent reduction of protozoa. No enteroviruses or fecal coliforms were detected in the final effluent. All measurements indicated that the recycled water was of a better quality than the water in the reservoir.

The Virginia State Water Control Board imposes strict conditions requiring that recycled water be monitored by an independent water monitoring agency. In addition, they require that any plant expansion be carried out in stages of no greater than 4 MGD. However, in more than 25 years of operation, there have been no water quality issues of health concern. Due to its 25 year track record of having consistently achieved good quality discharges, UOSA was given approval by the Virginia State Water Control Board to increase the plant capacity from 27 to 46 MGD instead of in 4 MGD increments.

Occoquan is often cited by water industry professionals as the longest running potable reuse project in the U.S. Occoquan is viewed as successful for two reasons:

- There was a serious water-quality problem to be solved and the project solved this problem creating very visible improvement.
- Water-quality credibility was achieved by forming a separate water quality authority, which continues to monitor and report on water quality.

West Basin Municipal Water District, El Segundo, California

The West Basin Municipal Water District is a wholesaler of treated, imported water to cities and other water systems in southwest Los Angeles County. The need to import drinking water became a critical issue in the 1950's when excessive groundwater pumping caused intrusion of ocean water into the potable water aquifers of the West Coast groundwater basin. A complex network of injection wells, called the West Coast Basin Seawater Intrusion Barrier, was constructed beginning in the 1960's by Los Angeles County to prevent any additional intrusion. Up until the mid-1990's, imported water was used as the sole source of injection water. In a major drinking water conservation effort, West Basin Municipal Water District built a water recycling facility to provide tertiary-treated recycled water for irrigation and industrial applications in their service area and advanced water treatment methods to replace a portion of the imported water injected for seawater intrusion control.

The approval process for using 100 percent recycled water underwent substantial expert and public review. A Blue Ribbon panel evaluated the treatment methods and water quality objectives and made a number of recommendations, many of which were incorporated into the DHS draft groundwater recharge criteria. Numerous studies were conducted that examined the occurrence, removal, and groundwater transport of total organic carbon, regulated priority pollutants, pathogens, disinfection byproducts, and trace contaminants, tentatively identified compounds, and pharmaceuticals.

The engineering report noted that, with the exception of ammonia concentrations, the recycled water exhibited superior water quality to the surface water supplies which they would replace (treated surface water from MWD), and represented an overall improvement in the protection of public health in this IPR project.

West Basin recently received regulatory approval from the DHS to increase the percent of advanced treated recycled water that can be injected into the groundwater to 75 percent (a staged approach to ultimately move to 100 percent recycled water, Rich Nagel, personal communication, 2004).

Las Vegas, Nevada

Since the 1950s, recycled water from Las Vegas has been discharged into the Las Vegas Wash, located between the Las Vegas metropolitan area and Lake Mead. Return flow credits permit a Colorado River water user to use and reuse the same water until it finally evaporates or sinks into the ground. Since Lake Mead is the primary source of drinking water for the Las Vegas region, as well as the destination for the region's recycled water, the principle of return flow credits allows Las Vegas to withdraw more than the 300,000 acre-feet from Lake Mead. For example, in

2001, approximately 420,000 acre-feet was withdrawn from the lake, with 120,000 acre-feet of return flow credits from the return of recycled water.

An additional concern has been raised by environmental groups in the area. Originally, the relatively small quantity of water discharged into the Las Vegas Wash created a wetlands and encouraged the establishment of a varied wildlife population. Wetlands vegetation helps clean the water that comes from the valley by filtering the water and further reducing pollutants as the water travels toward Lake Mead. The waterway also became a major rest area for migrating birds traveling through the western U.S. The increased quantity of water discharge has changed the habitat in recent years, and the wetlands areas are being destroyed by erosion. This has had a negative impact on the pollutant reduction that occurs in the wash; it is eliminating the wildlife habitat as well as producing additional sediment deposits in Lake Mead. The fact that the wetlands were artificially created by humans does not reduce the concern for their ongoing destruction. Erosion control features are now being constructed in the wash to slow water flow and control erosion.

Public health is always a concern when a potable water source includes recycled water. In the case of the Las Vegas Wash discharge, there is a large capacity for natural treatment and dilution in the cycle of water discharge through Las Vegas Wash to Lake Mead. At capacity, the lake holds approximately 28 million acre-feet of water, and even during severe droughts such as 2004, the reservoir holds approximately 14 million acre-feet of water. The 120,000 acre-feet of discharge (at 2001 flows) from the Las Vegas area is treated and disinfected to secondary treatment standards, then passes through the wetlands and stream beds of the Las Vegas Wash prior to reaching the lake, which holds more than 100 times the annual discharge.

Gwinnett County, Georgia

In 1995, Gwinnett County approved a new 20 MGD reclamation treatment plant called the North City Advanced Water Reclamation Facility (NCAWRF). This project is an example of IPR because numerous drinking water treatment intakes for the metropolitan Atlanta area are located downstream of the proposed discharge point. The proposed treatment included advanced secondary treatment for nutrient removal, membrane filtration, multi-media and activated carbon filters, and ozone disinfection.

The major public issue surrounding the proposed discharge of recycled water into Lake Lanier, a major source of drinking water for the metropolitan Atlanta area, was the potential aesthetic impacts such a discharge may have on the commercial and recreational activities around the lake. The idea of introducing recycled water into the lake close to the intake of a major drinking water treatment plant created relatively little public response compared to the environmental and economic concerns.

In 1999, the regulators delayed issuing a discharge permit for expansion of the NCAWRF until they could establish water quality standards for the lake. One year later, in early 2000, the standards were released; in November of the same year the State issued a National Pollutant Discharge Elimination System (NPDES) permit to Gwinnett County. Eventually, environmentalists and lakeside residents sued the county and state regulators, arguing that the discharge permit issued by the State for the expansion and discharge into the lake established treatment standards that were not as stringent as the plant's proposed capability based on the water quality produced in the already operating 20 MGD facility.

The plaintiffs' fear is that the water will eventually degrade the lake putting recreational users and habitat at risk. The concept of IPR does not seem to be the major issue, primarily because there are already other wastewater dischargers around the lake. The quality of these return flows is considered by many people (but not all) to be "cleaner" than the current lake quality with respect to drinking water quality, but not necessarily for maintaining the ecological health of the lake. The recycled water discharged into Lake Lanier would contain nutrients like phosphorus that may encourage the growth of algae and other aquatic plants.

An administrative law judge ruled against the environmental groups in September 2002, but a Hall County Superior Court judge reversed that ruling in March 2003. The Georgia State Supreme Court later struck down the permit that had been issued by the State ruling that Gwinnett County's discharge permit would not protect water quality in Lake Lanier. The Court stated that "the clear and unambiguous language of Georgia's anti-degradation rules require the permittee to use the 'highest and best (level of treatment) practicable under existing technology'". In the meantime, Gwinnett County has asked the regulators for a temporary permit to discharge 9 MGD into the Chattahoochee River above the 20 MGD already permitted for Gwinnett's existing reclamation plant.

Dublin San Ramon Services District, California

Dublin San Ramon Services District (DSRSD) proposed an IPR project using groundwater injection as the best and most cost-effective means to resolve their wastewater disposal problem created by rapid growth in their service area (Requa, D., personal communication, November 2004). The recycled water was to be injected into wells in Livermore but the majority of the water withdrawn would be delivered to Pleasanton and Dublin. The Environmental Impact Report process included an extensive public involvement program and an analysis of alternatives including local stream discharge and a seasonal storage reservoir. The DSRSD Board of Directors subsequently approved the project and moved ahead with design and construction.

The Pleasanton community believed that they were bearing the brunt of other communities' growth problems. In the face of strong public opposition, and when the need for additional wastewater treatment capacity was eliminated with approval for expansion of the ocean outfall, DSRSD withdrew the IPR component of their project and advanced the non-potable aspects of the project.

DSRSD entered into an agreement with the City of Pleasanton in which Pleasanton agreed not to challenge the project if DHS and the RWQCB approved the project. Upon completion of construction, DSRSD was approved to place the project into operation by these agencies. Ultimately, two of the agencies that were to receive the water withdrew their support of the project due in large part to their perception that public support of the project had been lost.

DSRSD dropped the project since it was no longer required to provide wastewater service, even though surveys indicated that a majority of the residents supported or accepted the project. Although the injection project that would have provided recycled water for IPR did not proceed, DSRSD has gone forward with non-potable reuse of this water supply.

The experience suggests that IPR projects are permittable in California. Community support is essential. Also, it could be inferred that a water supply agency is better suited to sponsor a water reuse project because water resource benefits are primary and wastewater disposal aspects are secondary. Public outreach and involvement should be thorough and continue throughout the development and construction of a project.

Orange County Groundwater Replenishment System

OCWD built Water Factory 21 in the 1970's to produce recycled water for injection into the groundwater to create a seawater intrusion barrier. The OCWD is proceeding with design and construction of a significant expansion/upgrade with advanced treatment technology. The number of seawater intrusion injection wells will be increased, a pipeline to deliver recycled water to the Anaheim Forebay (upper part of groundwater basin where current SAR spreading operations occur). According to Ruetten (2003):

The program has experienced success to date as OCWD has identified a clear set of problems that are perceived to be significant enough to warrant expansion of GWR and indirect-potable reuse These include protection of the aquifer against seawater intrusion, decreasing dependence on imported water supplies, improving drought resistance and reducing wastewater discharges to ocean beaches. In addition, they are using state-of-the-art treatment processes including reverse osmosis, have an established track record (with Water Factory 21) of being proactive with respect to emerging water-quality issues, have established themselves as a credible source of water quality information and their communication program is diligent and consistent.

These factors have fostered feelings of trust and credibility and are the basis for the success of the project so far. The only apparent water-quality issue that is still open is the desire by some key audiences to get the Department of Health Services (DHS) officially involved in the pre-treatment standards that govern the wastewater treatment plant.

6.0 Indirect Potable Reuse Opportunities

Indirect potable reuse (IPR) is the practice of taking recycled water that meets all regulatory requirements for non-potable use, treating it further with several advanced treatment processes to meet potable water standards, and adding it to an untreated potable water supply, usually a water body such as a surface water reservoir or a groundwater aquifer. The term "indirect" refers to the distinction that highly-treated recycled water is not plumbed directly to the potable distribution system. During a long residence time, the highly-treated recycled water blends with the source water, which is usually imported water and local runoff. This process is illustrated in **Figure 6-1**.

Extensive permitting and regulatory interaction is required prior to starting an IPR project. Regulations require the recycled water receive extensive advanced treatment, plus additional natural treatment processes that occur in a groundwater basin, stream or lake. Prior to entering the City's potable water system, the blended source water is treated at a potable water treatment plant or at a wellhead treatment facility. Treatment methods for IPR projects are described in detail in Appendix G.

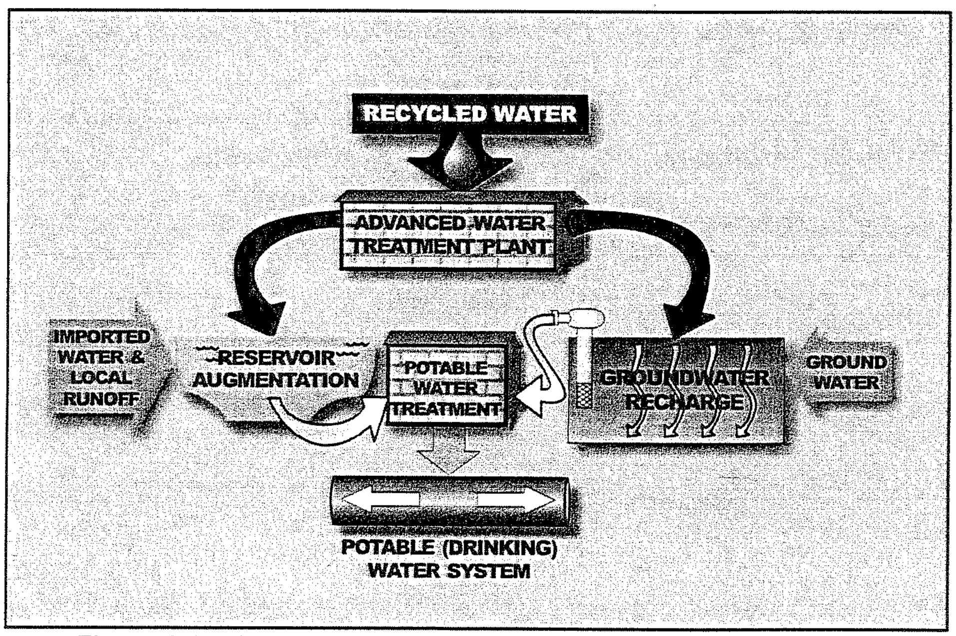

Figure 6-1 – Conceptual Indirect Potable Reuse Process Diagram

6.1 Reservoir Augmentation Opportunities

Reservoir augmentation is an IPR opportunity that involves adding advanced treated recycled water into a surface raw (untreated) water reservoir; the opportunities and constraints of this IPR method have been examined as part of the Study. Regulations require advanced treated water to be stored in the reservoir for a minimum of 12 months to blend with the untreated water within the reservoir and undergo a measure of natural treatment. Consideration was also given to the development of wetlands upstream from the surface water reservoir to provide additional natural treatment processes.

Any wetlands development upstream of a surface water reservoir would eventually result in advanced treated water entering into the City's raw water system and provide a new source of water beyond stormwater runoff and imported water. The option of creating wetlands as an aspect of each reservoir augmentation concept was considered, with certain factors examined, including the steepness of the basin surrounding each reservoir, the amount of time advanced treated water would be retained within a wetland, natural treatment provided, public access, City ownership of the land needed to construct the wetland and increased project cost of adding a wetland.

All nine City reservoirs – Sutherland Reservoir, Lake Hodges, Miramar Reservoir, Lake Murray, San Vicente Reservoir, El Capitan Reservoir, Morena Reservoir, Barrett Reservoir and Lower Otay Reservoir – were evaluated for reservoir augmentation concept projects. Sutherland, Morena and Barrett Reservoirs were determined to be unsuitable due to their distance from the City's existing recycled water facilities. Miramar and Murray Reservoirs were too small for further consideration, even for a small-scale reservoir augmentation project, since retention time requirements would not be met. Of the remaining reservoirs, Hodges and San Vicente Reservoirs underwent further consideration for North City reservoir augmentation opportunities, while Lower Otay Reservoir was considered further for South Bay. In each service area, both large-scale and small-scale reservoir augmentation projects were taken into account.

Northern Service Area – Reservoir Augmentation

The Study team's screening process of the City's nine raw water reservoirs determined that only Lake Hodges, San Vicente and Lower Otay were suitable candidate reservoirs for an IPR project. Lake Hodges is only suitable for a small-scale reservoir augmentation project because it is relatively small and has limited ability to provide the necessary retention time. San Vicente was most suitable for a large-scale reservoir augmentation project due to its large size and ability to provide the appropriate retention time. Drawbacks to San Vicente include its distance from the recycled water supply source. The San Vicente and Hodges proposed projects are shown in **Figure 6-2**.

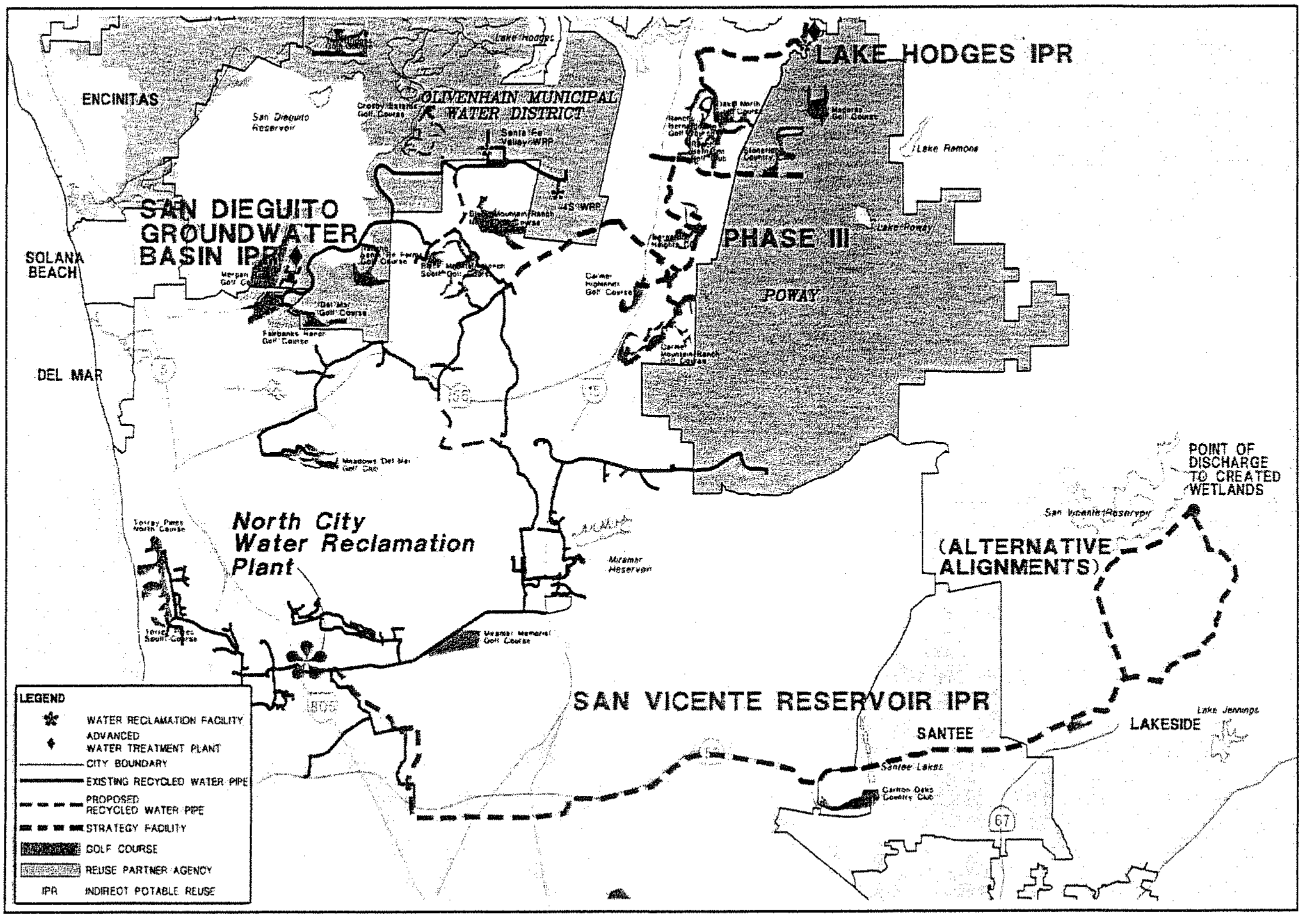

Figure 6-2 – Northern Service Area Indirect Potable Reuse Opportunities

Lake Hodges Reservoir Augmentation Project

A small-scale Lake Hodges reservoir augmentation project would require the implementation of the Phase III expansion of the Northern Service Area recycled water distribution system into Rancho Bernardo (see Section 5). At the northernmost end of the distribution system, an advanced water treatment plant would be sited in close proximity to the reservoir, and the treated water would be conveyed to Lake Hodges. This potential treatment facility would be capable of providing 2 MGD of water to supplement the local runoff and imported water stored in Lake Hodges. This blended water would subsequently be conveyed to drinking water treatment plants that serve both San Diego and North City areas. Upon completion of the Water Authority's Emergency Storage Project (ESP), water from Lake Hodges will also be available for distribution to areas further south, including the City's Alvarado and Miramar Water Treatment Plants. (See Figure 4.3 for the service areas of the City's three water treatment plants.)

The advanced water treatment facility would likely operate 8 to 10 months out of the year. The limited months of operation would be an effect of the seasonality of the Northern Service Area's existing and planned non-potable uses (i.e. a majority of the NCWRP capacity will be needed to serve non-potable uses during summer months for this option). Therefore, the advanced water treatment plant needed for this IPR project would be idle for these months. Brine disposal from the advanced water treatment plant would require new facilities to convey the brine to the City's existing sewer collection system, or north to City of Escondido treatment facilities.

San Vicente Reservoir Augmentation Project

A large-scale San Vicente reservoir augmentation project would include a 16 MGD advanced water treatment facility, located adjacent to the NCWRP. A 23-mile pipeline would be needed to convey the water to San Vicente. An optional wetland could be constructed near the reservoir to add a natural treatment process prior to the water entering the reservoir. Brine disposal would be accomplished by tying into the NCWRP brine disposal facilities. This large-scale project would beneficially maximize the recycled water available from the NCWRP.

The ESP includes at least doubling the volume of water stored in the San Vicente Reservoir. Raising the dam and construction of related water transmission facilities will allow delivering San Vicente water to all City water treatment plants and areas served by those plants. Therefore, the San Vicente reservoir augmentation project provides the greatest potential service coverage. (Figure 4.3 details the service area of the City Water Treatment Plant.)

Southern Service Area Reservoir Augmentation Opportunities – Otay Lakes

Both the small-scale and large-scale reservoir augmentation projects in the Southern Service Area, shown in **Figure 6-3**, involve the Lower Otay Reservoir. Conceptually, these projects would take recycled water from the City's SBWRP, treat it to advanced levels at an advanced water treatment plant, and then convey the water to the Lower Otay Reservoir via the Upper Otay Reservoir. A created wetland above the Upper Otay Reservoir could be constructed to add a natural treatment process prior to the water entering the Lower Otay Reservoir.

From Lower Otay Reservoir, the water would be withdrawn for treatment at the City's Otay Water Treatment Plant and distributed through the City's potable water distribution system to a majority of the South Bay area. Interconnecting pipelines between the City's Otay and Alvarado systems also allow water to be delivered north to the Alvarado Service Area. (Again, Figure 4.3 provides the service areas for the City's water treatment plants.)

The small-scale project would take advantage of the City's 1 MGD of capacity rights in OWD's recycled water distribution system expansion that is currently underway. A 2 MGD advanced water treatment plant would be located near Otay Lakes. Brine flows would be discharged into a trunk sewer belonging to the City of Chula Vista and eventually treated at the City's Point Loma Wastewater Treatment Plant.

The large-scale 5.5 MGD advanced water treatment plant would be located adjacent to the SBWRP. A 16-mile pipeline would be constructed to convey water to the reservoir, and brine would be discharged to the South Bay Outfall. This large-scale project beneficially maximizes the recycled water available from the SBWRP.

goal, use advanced water treatment. A common and effective form of advanced water treatment practice is soil aquifer treatment (AwwaRF, 2001; Asano et al, 2004, Drewes et al, 2003).

In soil aquifer treatment, the recycled water is first treated using tertiary and sometimes advanced methods as described above and then released into basins (such as dry river beds) where it slowly seeps into the groundwater. The water is ultimately pumped up and used (including for drinking purposes). Studies conducted over the past forty years have shown that a broad variety of organic and inorganic constituents are removed from the water as it seeps and moves through the soil. This method of treatment is used in Los Angeles and Orange Counties, California and elsewhere. It can be very effective at removing both organics and microorganisms (Bouwer et al, 1981; Anders, 2004; Snyder et al, 2004; Gerba et al, 1991).

Preliminary assessments suggest that advanced wastewater treatment plants and soil aquifer treatment systems effectively reduce the concentrations of Pharmaceutically Active Compounds (PhACs), but not always to concentrations below detection limits (Sedlak et al, 2005).

Wetlands Treatment – Many contaminants that are released into natural water environments can be removed or degraded by natural processes (Gearheart et al, 1988). Degradation by sunlight (Boreen et al, 2003; Horne 2000), uptake by plants (Horne 1995, 2000, 2003) and biodegradation can occur for some contaminants. Gersberg et al (1987) examined the survival of several indicators of viral pollution applied in primary municipal wastewater to artificial wetland ecosystems and found substantial removal possible. Taking advantage of these processes by constructing treatment wetlands is an option to help remove nutrients, metals, pesticides, and pathogens from urban runoff or wastewater.

Constructed wetlands can treat large volumes of water and can remove pollutants down to low levels but their effectiveness depends on how they are designed, operated, and maintained. In addition to reducing pollutants to low levels, constructed wetlands can enhance wildlife habitat, aesthetics, recreation, and property value. Natural wetlands, on the other hand, are generally not efficient at removing pollutants because the residence time (the time the water remains in the wetland) is often too short for effective treatment.

Treatment wetlands are not perfect however. Some contaminants appear to resist biodegradation especially when they are present at very low concentrations. Engineered treatment wetlands do not appear to have a large effect on concentrations of pharmaceuticals (Sedlak et al, 2005). Wetlands can also increase the concentration of some water contaminants. For example, recycled water treated by RO and discharged into wetlands would have such low levels of organic carbon to start with that the water would actually pick up organic carbon from decaying vegetation as well as salts (due to water evaporation in the wetlands).

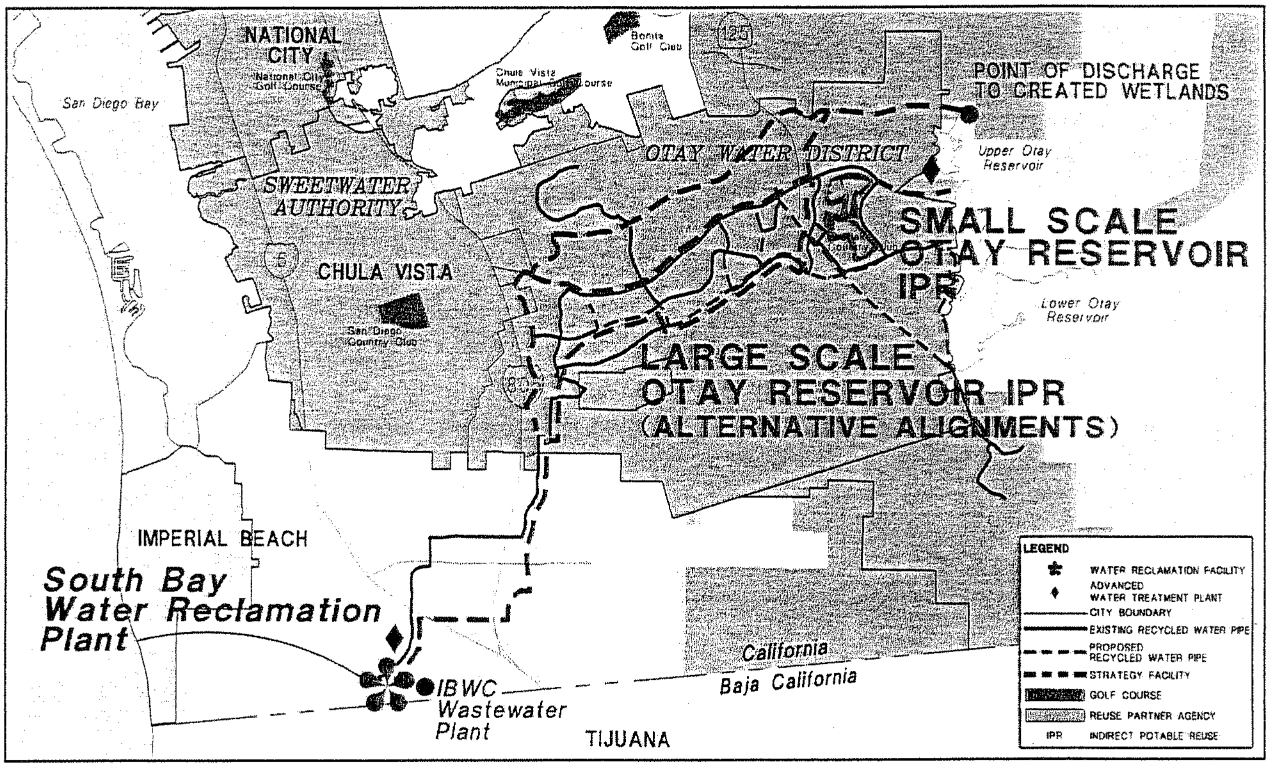

Figure 6-3 – Southern Service Area Indirect Potable Reuse Opportunities

6.2 Groundwater Recharge Opportunities

Advanced treated water may also be added to groundwater. Through direct injection into the aquifer via wells, or placed in spreading basins and allowed to percolate into the aquifer. The advanced treated water could blend with the groundwater and undergo natural treatment processes within the basin. The blended water would eventually be extracted, treated, and added to the potable water system (drinking water supply). This practice, referred to in the Study as groundwater recharge, must also meet minimum retention time and stringent water quality criteria as determined by RWQCB and DHS. Once extracted, a significant level of additional treatment may be necessary to achieve the required drinking water quality depending on the existing groundwater quality conditions.

The Study evaluated the feasibility of an IPR project using the City's existing groundwater basins. The San Pasqual, San Dieguito, Santee/El Monte, Mission Valley, San Diego Formation and Tijuana Groundwater basins were considered. Of these basins, San Dieguito was the only basin suitable for considering a groundwater recharge project at this time. The main factors taken into account for evaluating suitability were basin size, jurisdictional and economic issues, and overall water quality.

Domestic water use and insufficient retention time rendered the San Pasqual basin infeasible at this time. The Mission Valley basin displays certain benefits, such as simpler institutional issues and an improved ability to get water into and out of the basin, however, it is generally too narrow and shallow, and there are no planned recycled water conveyance facilities from either

The Study held its second Assembly workshop over the course of three days in July 2005. This second Assembly focused on three key objectives:

- Reviewing research materials that had been prepared on the various water reuse options covered in the Study's June 2005 Interim Report.
- Reviewing the strategies outlined for increasing water reuse from the two reclamation plants.
- Determining how well each of the evaluation criteria identified from the first workshop were applied to each reuse strategy outlined in the June 2005 Interim Report.

In their statement adopted at the workshop's conclusion, the group gave strong support for indirect potable reuse, a reservoir augmentation process that uses "advanced treated" or "purified" recycled water to supplement imported and runoff water supplies currently stored in the City's open untreated water reservoirs. Again, the statement featured both majority and minority viewpoints and is included as Appendix C. The following are five key excerpts from the second Assembly statement:

1. The Assembly believes the Water Reuse Study provides a useful and appropriate analysis of reuse strategies that can be used to inform policy-makers.

The Assembly reviewed the technical information and believes the Study provides a sound basis for the deliberations and conclusions of the American Assembly. The Assembly is appreciative of the technical support of members of the City's Independent Advisory Panel and Study Team.

2. The Assembly unanimously agrees that current technology and scientific studies support the safe implementation of non-potable and indirect potable use projects.

The Assembly considers advanced treated (purified) water to be superior in quality to other sources (e.g. Colorado River, State Project Water). The Assembly acknowledges that upon the outset of the study, many participants had reservations regarding the safety of the purified water, but have resolved those concerns through review of this Study and the City of San Diego Assembly on Water Reuse process. The participants are confident that the current research and technological advances in water treatment will produce water of higher quality than currently available. Advanced treatment and long term storage, current water quality regulations, standards and regulatory oversight were viewed as reasonable precautions to ensure public health and safety. Some participants of the Assembly recommend that regulations be revised to allow for direct potable use.

3. The Assembly feels that there are no environmental justice issues that would act as a significant impediment to implementation of indirect potable use strategies.

The Assembly concludes that service would be provided to a wide range of social and economic communities. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. The Assembly *believes that with proper information and community participation, any public perception of environmental justice issues can be overcome.*

4. Recommended Strategy for North City

The Assembly participants unanimously support strategy NC-3 (indirect potable use from North City Water Reclamation Plant). This strategy reduces reliance on imported water, has lower long-term costs, resolves current City litigation, distributes water broadly, and leads the City on a path towards water sustainability.

5. Recommended Strategy for South Bay

The Assembly participants expressed strong support for SB-1 and SB-3. The lower cost of SB-1 and the high percentage of water that is developed were attractive. However, SB-1 does not have the sustainability benefits that SB-3 offers and questions remain regarding dependency on a single large user. Many Assembly participants would favorably consider the SB-1 strategy if NC-3 (which emphasizes indirect potable use) is implemented.

The latter two excerpts of the Assembly statement refer to the strategies discussed in Section 7 of this report.

2.2 Public Outreach Activities

The 2003 California Recycled Water Task Force and the Assembly, as noted above, asserted that information, education and outreach are critical in addressing recycled water issues. The Study team embraced the importance of public participation and incorporated additional activities to supplement the Assembly process.

Public participation and briefing tasks began at the inception of the project. The Study team developed handouts, brochures, PowerPoint presentations, and a website. Monthly updates were sent to community members who had expressed interest in its progress, and a video was produced to enhance the outreach program.

Telephone and website surveys provided valuable insight into community viewpoints. By partnering with the San Diego County Water Authority in conducting a telephone survey, the City was able to collect statistically significant information and opinions from City residents. The City's informal online informational survey allowed additional opinions and input to be submitted directly to the Study team. Survey forms were also distributed at speaking engagements to collect opinions from audience members. In addition, focus groups were conducted to provide insight on residents' opinions on recycled water issues.

Telephone Survey

In June 2004, a telephone survey sampled 406 City residents and found that they support efforts to improve reliability and diversity of regional water supplies through the utilization of recycled water. Survey respondents were asked about their support for various non-potable uses of recycled water. These were ranked in the order of respondent support.

Preface

Water is essential to our growing economy and quality of life. The City of San Diego imports approximately 90 percent of its water supply from Northern California and the Colorado River. The City's other water sources are from stored local runoff and water recycling.

Over the past 20 years, the City's conservation programs have helped reduce per-capita water use, but population growth has continued to push up overall water use. Even with continued aggressive conservation efforts, the City projects it could need 25 percent more water in 2030 than today.

The City also faces challenges of ensuring its water supplies are reliable and environmentally sustainable. Existing imported supplies from the Colorado River and Northern California remain subject to reductions due to droughts. In addition, the need to import water, including water transfers, may also have incidental or unintended effects on other California ecosystems.

To address these challenges of growth, reliability and sustainability, the City's Long-Range Water Resource Plan identified the importance of recycled water in the City's overall water supply portfolio. The purpose of this Water Reuse Study is to conduct a comprehensive examination of the City's water recycling opportunities to support our future and our children's future.

Understanding the value and uses of recycled water is of critical importance in making informed choices and decisions. In developing recycled water uses, the City has several choices. Evaluating these choices requires considering more than just costs. Values, such as those listed below, will be at the heart of the public dialogue answering two critical questions: 1) what water recycling opportunities should be pursued?; and, 2) depending on the opportunity, how much water should be recycled?

Recycled water brings value to San Diego because it…

- *enhances the reliability of our water supply;*
- *promotes a sustainable balance with our environment;*
- *is a locally controlled resource;*
- *reduces water diversions from other California ecosystems; and,*
- *is an investment in San Diego's future.*

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City of San Diego Water Department Contact Information:

Marsi Steirer	Project Director	619-533-4112
Maryam Liaghat	Project Manager	619-533-5192
Ron Coss	Technical Manager	619-533-4160

Prepared In Coordination with:

City of San Diego
Water Department
600 B Street, Suite 600
San Diego, California 92101

PBS&J
9275 Sky Park Court, Suite 200
San Diego, California 92123

McGuire Environmental Consultants, Inc.

McGuire/Pirnie
8001 Irvine Center Drive, Suite 1100
Irvine, California 92618

The Water Reuse Study website address is:

http://www.sandiego.gov/water/waterreusestudy

Independent Advisory Panel

The Independent Advisory Panel (IAP) was established to provide independent oversight and guidance to the Study team. IAP panel members were contracted through the National Water Research Institute (NWRI), which was selected to ensure an unbiased and thorough examination of all possible water reuse opportunities. NWRI's mission is to promote the protection, maintenance and restoration of water supplies and aquatic environments through the development of cooperative research work.

The eleven panelists selected for the Study were renowned experts in the fields of water and wastewater technology, public health, epidemiology, toxicology, microbiology, water quality, economics, environmental engineering and science, public utilities administration and industry regulations from across the United States. The IAP also included a local citizen representative.

IAP workshops were held in July 2004, May 2005 and November 2005. The July 2004 workshop focused on the strengths and weaknesses of the reuse opportunities under consideration, proposed evaluation criteria and the parameters of the research studies on advanced water treatment being conducted. The May 2005 workshop reviewed the Interim Study Report providing significant suggestions regarding the reorganization and enhancement of the Study contents as well as the comprehensive science-based projects. The final IAP meeting in November 2005 gave the Study Team a detailed critique of the Final Draft Water Reuse Report and the Panel issued their findings which are included in Appendix E. The following is an excerpt from the IAP's findings:

> *"It is the unanimous conclusion of the Panel [IAP] that appropriate alternative water reuse strategies for the City of San Diego have been identified, and that these alternatives have been presented clearly so that the citizens of the City of San Diego can make informed choices with respect to water reuse."*

The members of the IAP and their areas of expertise are listed below. Dr. Tchobanoglous chaired the IAP and Dr. Gersberg served as vice-chair.

Richard Bull, Ph.D., Toxicologist, MoBull Consulting (Richland, WA), *Toxicology*

Joseph A. Cotruvo, Ph.D., Risk Assessment, Joseph Cotruvo Associates (Washington, D.C.), *Environmental and Public Health*

James Crook, Ph.D., P.E., Water Reuse Consultant (Boston, Massachusetts), *Environmental Engineering and Regulatory Issues*

Richard Gersberg, Ph.D., Professor and Division Head of Occupational and Environmental Health; Director, Coastal and Marine Institute, San Diego State University, (San Diego, CA), *Ecological Research and Environmental Health*

Christine L. Moe, Ph.D., Associate Professor, Department of International Health, Emory University (Atlanta, GA), *Epidemiology and Microbiology*

James E.T. Moncur, Ph.D., Director Water Resources Research Center and Professor of Economics, University of Hawaii (Honolulu, HI), *Economics*

Derek Patel, M.D., Assistant Clinical Professor of Medicine, University of California San Diego (San Diego, CA), *Clinical Physician specializing in Gastroenterology*

Joan B. Rose, Ph.D., Homer Nowlin Endowed Chair for Water Research, Michigan State University (East Lansing, MI), *Microbiology and Water Quality*

George Tchobanoglous, Ph.D., P.E., Professor Emeritus, University of California, Davis (Davis, CA), *Environmental Engineering*

Michael P. Wehner, Director of Water Quality and Technology, Orange County Water District (Fountain Valley, CA), *Water Quality and Public Utilities Administration*

Fred Zuckerman, Mechanical Engineer, Member of the Tierrasanta Community Council (San Diego, CA), *Local Perspective*

1.4 Methodology

An overview of the four major phases of the Study from inception to completion is displayed in **Figure 1-2**. Stakeholders and the City's public involvement efforts played a significant role in crafting the Study's approach and process.

Stage I – Project Definition

Provided the basis of the Study, the information from which water reuse opportunities could be analyzed was split into two concurrent efforts.

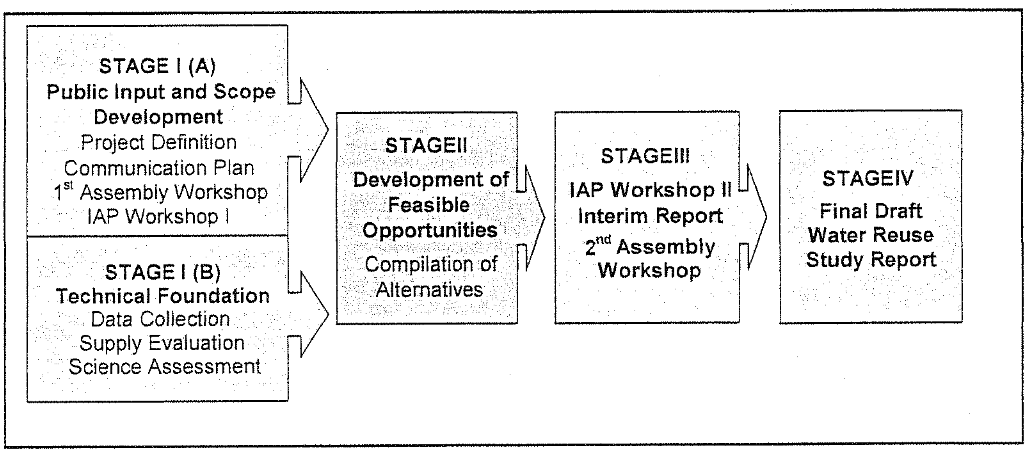

Figure 1.2 – Water Reuse Study Methodology Diagram

Stage I (A) – Public Input and Scope Development

In Stage I (A), stakeholder efforts and public involvement took center stage. A broad range of stakeholders were solicited for participation in the first Assembly workshop, which convened in October 2004. July 2004 saw the first meeting of the IAP. Public viewpoints were solicited through community meetings, San Diego Speakers Bureau (Speakers Bureau) presentations, focus groups and surveys. A website (http://www.sandiego.gov/water/waterreusestudy) was developed and debuted on August 5, 2004. The website included Study information, facts and terminology related to recycled water, and a survey where the public could provide their input on recycled water.

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